

A preliminary biotelemetric study of a feral invasive *Xenopus laevis* population in France

Christophe EGGERT* & Antoine FOUQUET**

* Laboratory of Alpine Ecology, UMR CNRS 5553, CISM, University of Savoie,
73376 Le Bourget du Lac, France
<eggert@univ-savoie.fr>

** Le Buisson Garroux, 79100 Mauzé-Thouarsais, France

The invasive African clawed frog (*Xenopus laevis*) is currently spreading over a large area in western France. In order to investigate the population expansion processes we studied the feasibility of implanted transmitters use. Seven frogs were radiotracked during the winter period. Even in this cold period of the year, individual movements were observed in the natural water network, and also in the flooded terrestrial surrounding area. These areas play a key role in the invasive process. During the study, freezing and predation by the polecat (*Mustela putorius*) seemed to be the major adult mortality factors.

INTRODUCTION

Introduction of non-native organisms into the wild for economic, sport, aesthetic reasons, or accidentally, are very common processes occurring at a growing rate since the last century. If in many cases non-native organisms may be harmless in their new environment, in other cases they prone to escape human control and could become invasive (WILLIAMSON, 1996). Like many animal groups, amphibians have also been the subjects of the invasive process. The African clawed frog, *Xenopus laevis*, is one of the known invasive frog species, currently established in many non-native area, principally in California, Arizona and north Mexico since the sixties (CRAYON, in press), and in Chile and south Wales since the seventies (MEASEY & TINSLEY, 1998; LOBOS et al., 1999, LOBOS & MEASEY, 2002). Many other more or less isolated populations have also been noticed, including on Ascension Island in the south Atlantic Ocean since 1944 (TINSLEY & MCCOY, 1996, CRAYON, in press). Quite recently feral African clawed frogs have been discovered in western central France (FOUQUET, 2001) and are suspected to have become established since the eighties. It may be the largest known European population since its known range was about more than 100 square kilometers in 2003, which is likely to be largely underestimated and quickly increasing (FOUQUET & MEASEY, 2006).

According to climatic conditions, French feral *X. laevis* suffer almost the same conditions as in south Wales, which have been described as ill-suited to this southern African species

(MEASEY & TINSLEY, 1998). The south Wales populations have been intensively studied regarding their demographic parameters and feeding habits (MEASEY & TINSLEY, 1998; MEASEY, 1998, 2001), and they seem to occur only within a limited area (MEASEY & TINSLEY, 1998). A skeletochronological investigation shows that successful recruitment infrequently occurs (MEASEY & TINSLEY, 1998, MEASEY, 2001), potentially limiting *X. laevis* spread. Therefore, the dispersal success of *X. laevis* in the French countryside calls for some explanation. Surprisingly, the African clawed frog, despite being a standard for developmental, physiological or molecular laboratory studies, remains poorly known regarding its population ecology, even in its native habitats (MEASEY, 2004). The goals of this study are (1) to test the use of implantable transmitters to track clawed frogs in the wild, and then (2) to observe frogs' movement and winter mortality during cold wet season in the area inhabited in France.

MATERIAL AND METHODS

STUDY AREA

We chose one of the numerous colonized ponds of the current frog's distribution, according to the following criteria: permanent pond, resembling many other colonized ponds and surrounded by a maximum diversity of landscapes, not situated in the border of the occupied area, not holding a high density of African clawed frogs. The chosen pond was located near Vibreuil (46°59'N, 00°19'E), in the middle of an extensive pasture, surrounded by typical traditional hedges, including small groves, wooded hedges and ditches (fig. 1), and also ploughed fields. The pond, shaped with strong sloping banks except on one side, serves as watering place for some cattle. Its depth was about 200 cm maximum during the study. It was free of fish, contained very little vegetation, and during the study few other amphibian species were caught (*Triturus cristatus*, *T. helveticus*). The pond was supplied with water by small ditches collecting rainwater from the nearby pasture area, but also sometimes by overflow from the same continuous small ditches which are connected further up to a larger water network. The pond was connected to the water network only during the wet seasons, i.e., probably only a few months each year.

SAMPLING OF CLAWED FROGS AND TELEMETRIC PROCEEDINGS

African clawed frogs were caught using funnel traps baited with pieces of meat (FOUQUET & MEASEY, 2005) from November 2002 to February 2003. Traps were set for one or two consecutive nights in the water. Then frogs were brought to the lab for transmitters implantation. They were sexed, weighed and measured with a calliper to the nearest millimeter. According to the implantation method described by EGGERT (2002), frogs were anaesthetized and transmitters (Sirtrack, Single Stage Transmitters) were placed through a small incision in the body cavity. The abdominal muscles and skin layers were then sutured together in two separate layers. The animals were kept for a few days in aquarium to verify full recovery before releasing in the exact place of capture. Animals were located about once a week, sometimes

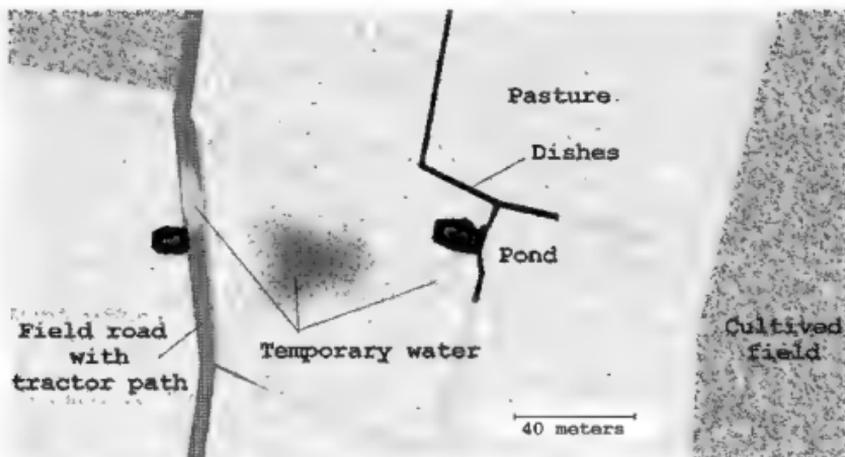


Fig 1 – Situation plan of the studied area of feral clawed frogs in France.

less during very cold weather conditions. They were located with at least half a meter accuracy. When death of a frog was suspected in the water, we tried to catch it with a landing net.

RESULTS

Seven frogs (4 males and 3 females) were caught in the pond and then tracked during winter (tab. 1)

Most of the frogs' movements were limited to the pond, but sometimes frogs went out of it. Thus 19.6 % of the frog locations were situated in surrounding dishes and 21.6 % in temporary puddles. Only one individual (female 696) did not leave the pond but after 8 days the transmitter was found alone and damaged some meters out of the pond in the pasture. In the same way a male (male 555) was predated after a two weeks trip in the small ditches upstream from the pond. In both cases we assume that the western polecat (*Mustela putorius*) was the predator (polecat faeces were found very close to the still working transmitters). Two males were tracked until transmitter signals were lost for unknown reasons, but in both cases polecat action is suspected. One was lost just after releasing, while the other (male 1036, see fig. 2) was tracked for two months. Two dead individuals were found in the pond, close to its border, without any evident cause of death. One (male 059) had shown a constant movement activity (but mainly in the pond) during the 3 weeks of tracking, whereas the other (female 436) was found dead only one week after release. In both cases post-operative problems cannot be excluded, even if posterior autopsies have not revealed any apparent injuries, except a slight inflammation in the region of the incision.

Table 1 – Some data on radiotracked feral clawed frogs in France (November 2002-February 2003)

Sex/code	Size mm	Mass g	Date of capture	Last control	Cause of loss
Male 059	69	45.0	17 November	14 December	Death
Male 555	68	47.0	16 November	01 December	Predated
Male 696	71	42.7	09 February	20 February	Unknown
Male 1036	74	46.7	13 December	16 February	Unknown
Female 436	89	85.7	23 November	14 December	Death
Female 398	94	99.1	23 November	16 February	Dead frozen
Female 696	99	114.1	23 November	14 December	Predated

The first two weeks of December were cold (but without freezing), whereas the two last were milder (a temperature up to 10°C during the day was observed). January was very cold, with most of the night temperatures below 0°C, like in mid-February. Soil and water became colder during January, freezing during the first week of February. At that moment, all wetland habitats were covered with 10 centimeters of ice. One individual (female 398) which moved about 80 meters from the pond (fig. 2), moved overland through pasture, crossing a wooded hedge then was located in a puddle 20 centimeters deep. It died in early February by freezing.

DISCUSSION

IMPLANTATION PROCEDURE

As laboratory kept frogs often perform an overhead kicking movement with their clawed feet, it was necessary to sew up the suture using a large amount of skin. Moreover it was not possible to keep clawed frogs for a long time in dry conditions, so that healing was considerably longer than in terrestrial amphibians (pers. obs.). Stitches of one female break just after sewing up and therefore we sewed them again with a larger suture, with a larger recovering of the two facing skin parts. We suggest using absorbable gut for the muscle layer and nylon suture for the skin closure. Also broad-spectrum antibiotics to prevent infections in the wild could be tested. Likewise avoiding cold water temperatures during healing process may increase healing rate (COLBERG et al., 1997).

CLAWED FROGS MOVEMENTS

In spite of the rather cold weather conditions during the course of our study, clawed frogs' movements were not limited to the pond. Trips in the connected small dishes, with lower

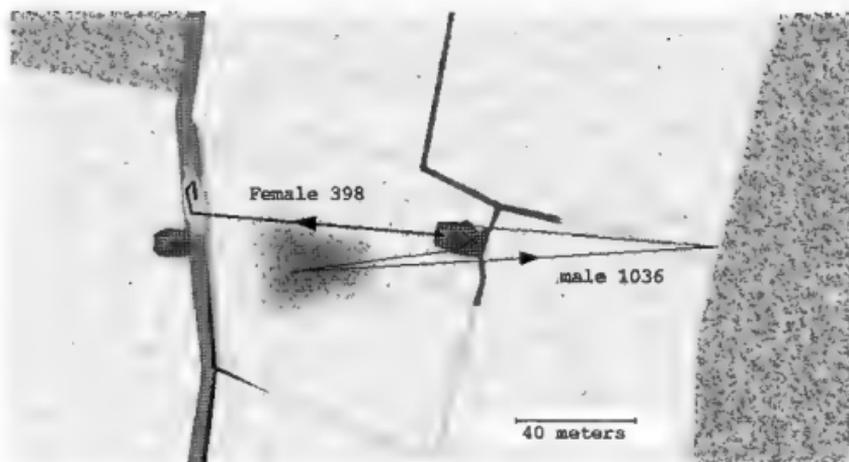


Fig 2 Example of clawed frogs movement in the study site during the tracking period (see text) The other tracked frogs did not move further than these.

water level (maximum about 40 cm), were observed, as well as overland movements. Therefore, during winter, clawed frogs could be found not only together in ponds or rivers, but also alone or in small numbers in small temporary puddles unconnected with permanent or temporary streams. The use of such temporary water places, that are numerous in this agricultural region, should clearly be considered in any planned eradication program. Moreover, clawed frogs are able to move even in quite cold weather conditions. By marking individuals during several years in the UK, MEASEY & TINSLEY (1998) observed that less than 36% of the frogs were moving between capture sites, mainly over few hundred meters, with a maximum of two kilometers along a river valley. Overland movements could occur through woodland with dense undergrowth, over metalled roads and also across rivers. In our study, leaving the pond was associated with high risk of mortality by contact with predators or by freezing in a temporary water surface (also several young *X. laevis* have been found dead in a shallow pond after a cold period; pers. obs.). Nevertheless, the relationship between animals with implantable transmitters and predation probability remains to be studied. Severe winters have been proposed as a major factor affecting clawed frog introduction success in European area (FRAZER, 1964). Freezing or suffocation underneath ice layer have long been reported for European amphibians (e.g. *Rana temporaria* in DE LA FONTAINE, 1881). It was obviously a cause of *X. laevis* mortality in France but clearly does not prevent its invasion.

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